INSTRUCTION BOOK

MODEL 95A

SENSITIVE DC METER

Serial No. 451 and above

BOONTON ELECTRONICS CORPORATION

Serial No. _____

I N S T R U C T I O N B O O K

MODEL 95A

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BOONTON ELECTRONICS CORPORATION

ROUTE 287 AT SMITH ROAD
PARSIPPANY, N. J.— 07054

95A SENSITIVE DC METER

AMMENDMENT SHEET 1

W A R N I N G

Prevent damage to input circuits when measuring small currents. Be sure chassis link is open. Your current source may be at sufficient potential to ground to burn low value input resistors.

I M P O R T A N T N O T E

For measurements at maximum sensitivity the atmosphere must be controlled to contain no more moisture than that present at 75°F when the relative humidity is 50%.

The reason is, that contamination present in moisture on insulating materials supporting input connections and input switches supplies an electrolyte between these connections thus causing a minute potential to be produced. This gives an unavoidable zero shift on the most sensitive ranges which can be outside the range of the zero control.

TABLE OF CONTENTS

Section		Page
I	Specifications	1
II	General Description	3
III	Operating Procedure	4
IV	Theory of Operation	10
V	Calibration & Checkout	13
VI	Replaceable Parts List	20
	Warranty	26
	Schematic	

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SECTION I

MODEL 95A

SPECIFICATIONS

Voltage Range:	± 1.0 microvolt to 1,000 volts dc
Current Range:	± 0.1 μμa (10^{-13}) to 1.0 ampere dc
Input Capacitance*	50 μμf (Approx.) without cable 175 μμf (Approx.) with cable
Input Resistance:	
Voltmeter:	10 megohms all ranges
Ammeter:	1.0 μμa to 100 μμa Range: 10 megohms

300 μμa:	3.33 megohms	1 μa:	1K ohms
1 mμa:	1.0 megohms	3 μa:	333 ohms
3 mμa:	.333 megohms	10 μa:	100 ohms
10 mμa:	100K ohms	30 μa:	33.3 ohms
30 mμa:	33.3K ohms	100 μa:	10 ohms
100 mμa:	10K ohms	300 μa:	3.33 ohms
300 mμa:	3.33K ohms	1 ma to 1a:	1.0 ohm

Full Scale Sensitivities:	
Voltage:	± 10 microvolts to 1,000 volts dc
Current:	± 1.0 micromicroampere to 1 ampere
Accuracy:	
Voltmeter:	± 3% of Full Scale
Ammeter:	± 4% of Full Scale
Ranges:	
Voltmeter:	17 Ranges 1,3,10,30 etc. sequence
Ammeter:	25 Ranges 1,3,10,30 etc. sequence
Noise:	1 μv PP (approx.) referred to input
Drift:	less than ± 2 μv after 30 minute warm up referred to input.
Bandwidth:	1 cycle at 3 DB
60 Cycle Rejection:	greater than 60 DB

* Input capacitance measured with 100 KC Test Frequency

SECTION I

MODEL 95A

SPECIFICATIONS (CONT'D)

Amplifier: Gain 100,000 maximum

Output: 0 to ± 1.0 volt into 1,000 Ω load polarity same as applied input. Output is continuously adjustable.

Output Ripple: Less than .01V RMS

Output Impedance: Approximately 400 Ω

Overload Tolerance:

RANGE	OVERLOAD TOLERATED	OVERLOAD FACTOR
10 μv	10V	1M
30 μv	10V	300K
100 μv	10V	100K
300 μv	10V	30K
1000 μv	10V	10K
1 mv	10V	10K
3 mv	30V	10K
10 mv	100V	10K
30 mv	300V	10K
100 mv	1000V	10K
300 mv	1000V	3K
1000 mv	1000V	1K
1 V	1000V	1K
3 V	1000V	300
10 V	1000V	100
30 V	1000V	30
100 V	1000V	10
300 V	1000V	3
1000 V	1500V	1.5
1 μμa	1 μa	1M
3 μμa	1 μa	300K
10 μμa	1 μa	100K
30 μμa	1 μa	30K
100 μμa	1 μa	10K
300 μμa	3 μa	10K
1000 μμa	10 μa	10K
1 mμa	10 μa	10K
3 mμa	30 μa	10K
10 mμa	100 μa	10K

SPECIFICATIONS (CONT'D)

RANGE	OVERLOAD TOLERATED	OVERLOAD FACTOR
30 mμa	300 μa	10K
100 mμa	1 ma	10K
300 mμa	3 ma	10K
1000 mμa	10 ma	10K
1 μa	10 ma	10K
3 μa	30 ma	10K
10 μa	100 ma	10K
30 μa	100 ma	3K
100 μa	300 ma	3K
300 μa	300 ma	1K
1000 μa	3 A	3K
1 ma	3 A	3K
3 ma	3 A	1K
10 ma	3 A	300
30 ma	3 A	100
100 ma	3 A	30
300 ma	3 A	10
1000 ma	3 A	3

Pôwer Requirements:		105 to 125V, 50-60 cycles, 40 watts
		210 to 250V, 50-60 cycles (Special)
Size:	Portable	7-1/2W X 9-1/2D X 11H EXCLUDING HANDLE.
	Rack	19 W X 11-3/4 D X 5-1/4 H WITH HANDLE
Weight	Portable	17 lbs. packed.
	Rack	Approx. 22 lbs. packed.

SECTION II

GENERAL DESCRIPTION

The Model 95A DC Meter is a combination voltmeter, ammeter, and amplifier. It is designed for DC measurements over the range of 1.0 microvolt to 1,000 volts as a voltmeter, and 0.1 micro-microampere to 1.0 ampere as an ammeter. Seventeen voltmeter ranges are provided, which cover from 10 microvolts full scale to 1,000 volts full scale in sequential ranges of 1,3,10, 30 etc. Twenty-five ammeter ranges cover from 1.0 micromicroampere full scale to 1.0 ampere full scale in the same range sequence.

As a DC amplifier the Model 95A has a maximum gain of 100 db and is capable of providing $\pm$ 1.0 milliampere into a 1,000 ohm load. The output is continuously variable to plus 100 db by means of the front panel gain control and range switch. An output bias control in the instrument allows the adjustment of output to any current between 0 and 1.0 milliampere with zero input. The output at the binding posts may be used simultaneously with the meter without interaction.

The input circuit may be operated either grounded or floating. The instrument case and panel are connected through the power line cable to ground. Terminal 1 of the input receptacle is connected to the amplifier chassis which is insulated from the instrument case by approximately 500 megohms. The amplifier chassis may be grounded by connecting a jumper between terminal posts located on the front panel of the instrument.

The Model 95AR DC Meter is identical to the Model 95A electrically. Physically, the components have been rearranged to mount on a 5-1/4" X 19" Standard rack panel. An additional rear input (J3) is provided, and the Output Bias Adj. (R32) has been moved to the front panel for accessibility.

Table 1-1

Equipment Supplied:

No. per Equipment		Dimensions
1	Model 95A Sensitive DC Meter	$12\frac{1}{4}$ H x $7\frac{1}{8}$ W x $9\frac{1}{8}$ D
1	Input cable assembly	4 ft. approx.
2	Insulated alligator clips (1 red, 1 black)	
1	Instruction book	

Table 1-2

Electron Tube Complement:

No. per Equipment	Type	Function
1	6X4	Rectifier
1	OA2	Voltage Regulator
1	12AX7	Amplifier (Special)
1	6AU6	Amplifier
2	12AT7	Amplifier

Table 1-3

Fuse Complement:

1 Fuse	AGC 0.5 ampere

Table 1-4

Chopper Complement:

1 Mechanical	BEC #540,108
1 Transistor	2N404A

SECTION III

OPERATING PROCEDURE

3-1 General

3-2 This section describes in detail the operating procedure for the Model 95A Sensitive DC Meter. All information required for safe and proper operation of the instrument is included. Be sure to read this section before placing the instrument into operation.

3-3 Initial Turn-On Procedure and Tests

3-4 Tests. To perform the initial tests proceed as follows:

a. After unpacking the unit, and before plugging it into an ac outlet for the first time, turn the instrument back and forth several times to make sure the tubes have not fallen from their sockets due to rough handling.

b. Observe the meter pointer to see that it moves freely and rests at zero when the instrument is steady.

c. If the pointer rests to the right or left of zero, set it at zero with the zero set screw.

CAUTION

Verify that the power source and power rating plate agree or that a suitable converter is used.

3-5 Turn-On Procedure. To perform the initial turn-on procedure proceed as follows:

a. Plug the instrument into the power source.

b. Connect input cable assembly to the instrument at jack marked INPUT.

c. Set the toggle switch to ON (up), and allow a warm-up period of approximately 10 minutes.

d. Short the black and red clips of the input cable.

e. With the FULL SCALE selector switch set to 10, and the RANGE selector switch set to μv, adjust the meter electrically to zero using the control marked ZERO. Then as the FULL SCALE and RANGE selector switches are moved to each position the meter should remain at ZERO.

CAUTION

In an instrument capable of indicating an input signal as small as a fraction of a microvolt, several sources of unwanted meter indications are of importance. Two of the most common of these are hum pickup and thermal voltages.

The 95A includes a 60 cycle rejection filter which reduces hum pickup effects by more than 60 db. Ideally the 95A should not be placed in the presence of a strong ac field. If this cannot be avoided, the instrument and input terminals should be carefully shielded.

Thermal voltages are the result of a temperature change at the junction of dissimilar metals. In the input circuit of the 95A considerable care has been taken through the choice of materials and placement of parts to minimize thermal voltages. Similar care must be taken with the circuit to which the input cable of the 95A is connected. (The insulated alligator clips provided with the 95A are made of berryllium copper. When attached to the phone tip prods of the input cable and shorted to each other the resultant thermal voltage is negligible). A zero offset when connected to the external circuit may be the result of thermal voltages; however, in some instances it is difficult to differentiate between thermal and ac field effects.

In general if a cause and effect relationship can be observed between a temperature change in the external circuit and a 95A Meter movement, then it can be assumed that thermal voltages are present. For greatest accuracy at high sensitivity these thermal voltages must be eliminated either through the choice of proper materials in the circuit or the maintenance of a constant temperature in the external circuit environment.

Other effects that may produce unwanted deflections of the 95A are:

a. Galvanic action (battery effects).

b. Photosensitivity (particularly of semiconductor devices).

c. Amplifier noise (caused usually by noisy tubes, resistors, or capacitors in the input stage).

f. Set the FULL SCALE and RANGE selector switches to the desired measuring range, and the instrument is ready for operation. If the voltage or current to be measured is unknown, it is desirable to connect the 95A with the selector switches in the least sensitive ranges, then switch down range until meter indication is observed.

g. Input impedance: (see SPECIFICATIONS)

CAUTION

The 95A employs a mechanical interlock in the range switching mechanism. This prevents the instrument from being switched to the 1 and 3 FULL SCALE position when the RANGE switch is in the μv range or vice versa.

It is necessary to switch either the FULL SCALE switch to 10 or above in order to use the μv range, or to switch the RANGE switch to the mv range, or higher, in order to use the 1 and 3 FULL SCALE ranges.

3-6 Amplifier Output

The dc output of the Model 95A is available at terminal posts on the front panel. This output may be used to operate a dc recorder or to trip limit determining relays in an automatic test set-up. An output bias control (OUTPUT BIAS ADJ). on the right side of the case (front panel of rack mounted units) allows the output level to be adjusted to a desired reference level on the recorder. The amplifier gain is continuously adjustable from 0 to+100 db by means of the range switch and the gain control located on the front panel. The amplifier may be operated simultaneously with the DC meter indications.

SECTION IV

THEORY OF OPERATION

General.A simplified block diagram is shown in Figure 1. The circuit consists of an input range switch, a filter to reduce the effect of the external hum pick-up, a chopper which converts the dc to ac at the power line frequency, a four stage negative feedback amplifier, a transistorized synchronous rectifier that reconverts the amplifier ac to dc, a zero-center dc microammeter indicator, a cathode follower output amplifier, and a power supply.

Range Switch. The input dc voltage or current is applied to two 7-position switches, which on the five most sensitive voltage and current measuring ranges effects its control by varying the amount of feedback in the amplifier. On all other voltage ranges the input voltage is divided to maintain a constant attenuator output of 1 millivolt to apply to the low pass filter. On the current measuring ranges from 300 micromicroamperes to 1.0 milliampere various resistors are switched across the input in order to correlate the 1.0 millivolt correctly in terms of current. From the 3.0 ma range to the 1.0 ampere range the input resistor remains 1.0 ohm and the voltage sensitivity is changed to calibrate the current ranges correctly. The input circuit has the ground carried through a connector contact to minimize ground loops and series resistance problems which may occur if ground is carried by the connector shell. The shielded input cable is terminated in insulated phone tips with beryllium copper to reduce thermocouple effects which occur when connecting conventional steel clips to brass or copper conductors.

Low Pass Filter. The range switch output is applied to a multi-section low pass filter which will attenuate unwanted 60 cycle pick-up by a minimum of 60 db. Frequencies above a few cycles are attenuated by the filter. This restricts the use of the 95A to dc or very low frequency ac applications. Because the amplifier has been designed for a very high 60 cycle gain (for amplifying the low level 60 cycle output of the chopper), the rejection of unwanted 60 cycle voltages at the input becomes a necessity.

Converter Chopper. The dc at the filter output is applied to a low-noise mechanical chopper where it is converted to an ac voltage of the same frequency as the ac power source. The chopper-amplifier combination is insensitive to variations in line frequency over a range of approximately 50 to 60 cycles. A bias voltage applied to one side of the chopper serves as the meter zero adjustment.

Amplifier. The chopper output is capacitively coupled to a two stage low-noise, non-microphonic, dual triode amplifier. The third stage is a high gain pentode which couples into a medium gain amplifier stage consisting of half of a dual triode. The remaining half of the dual triode operates as a cathode follower. The stages of the amplifier are resistance-capacitance coupled. These coupling networks and associated filters have been designed to peak in the 50 to 60 cycle region with pronounced fall-off in gain below and above this band. This band-pass characteristic adds to the attenuation effect of the low pass input filter in minimizing the error caused by the pick-up of unwanted high or low frequency voltages. A portion of the output is applied out-of-phase to the first and third stages. The amount of this feed-back is selected by the range switch to give the required overall gain on each of the five most sensitive voltage and current ranges.

Synchronous Rectifier. The output of the final ac amplifier, a cathode follower, is applied to a transistor rectifier. The driving voltage for the transistor is phased so that the polarity of the rectified voltage is the same as the polarity of the voltage at the input of the DC Meter. The polarity and amplitude of the rectifier output are indicated on the 6-inch zero center meter.

Power Supply. The power supply circuits provide: a regulated +150 volts for the plates of the tubes in the first four stages of the amplifier, +190 volts unregulated for fifth amplifier stage and the cathode followers, a low voltage dc for the filaments of the first three stages of the amplifier. The remaining filaments are operated from 6.3 volts ac from the power transformer. A -14v bias voltage is also supplied for meter zeroing and the output cathode followers.

Cathode Follower. The pulsating dc voltage from the transistor rectifier is applied to a gain control (OUTPUT LEVEL-R26) which varies the input to the grid of one triode of a balanced cathode follower. The OUTPUT BIAS ADJ. control (R32) is in the grid circuit of the other or balancing triode. The adjustment range of the OUTPUT BIAS ADJ. control (with no voltage at the input) is from a small negative current to more than +1 ma in a 1000 ohm load. Output filtering is accomplished by a smoothing filter in the grid circuit of the signal cathode follower, which is also capacitively coupled to the grid of the balancing cathode follower. The polarity and magnitude of the dc output is proportional to the dc input.

SECTION V

CALIBRATION & OPERATIONAL CHECKOUT PROCEDURE

EQUIPMENT NEEDED:

MEGOHMMETER: Freed type 1020B or equivalent

VARIABLE TRANSFORMER: Superior Electric Powerstat Type 2PF10 (1A) or equivalent.

RESISTANCE BRIDGE: Electro-Measurements Model 230R

DC NULL DETECTOR: Boonton Electronics Model 56A

VOM: Triplett Model 630A or equivalent

ACVTVM: Ballantine Model 314 or equivalent

RECORDER: Rustrak Model A or equivalent

2.2K 1/2W 5% Resistor

1K 1/2W 5% Resistor

DC Voltage source variable from 10μv to 1000 V ±0.5%

DC Attenuator in 20% steps

DC Current Source variable from 1μμa to 1 amp ±0.5%

A. NON-OPERATING INSPECTION

1. Meter zero adjustment. If the pointer is off zero, rotate the screw located in the center of meter case CCW or CW until the pointer rests at zero.
2. Remove the shorting link between ground and floating chassis posts and connect the megohmmeter across the posts. Normally the resistance measured should be about 1000 megohms. However; in the presence of high humidity it may measure as low as 200 megohms.

B. VOLTMETER CALIBRATION

Using the Powerstat set line voltage to 115 VAC and allow instrument to warm up for at least 15 minutes. Reconnect shorting link. Be sure to use the adapter plug attached to the end of the line cord with the ground wire unconnected. This will open any ground loops that may exist, which if they existed, might affect the calibrating accuracy of the instrument or the making of any low voltage measurements. It should be noted that under normal operating conditions when the standard NEMA plug (three prong power plug) and receptacle are used, the grounded binding posts and black input cable clip are at power system ground potential.

1. Electrical Zero Set: With input leads shorted and the range switches set for 1 mv full scale, set the zero control to the center position. Adjust R98 Located on top of amplifier chassis) for a meter indication of zero.
2. With input cable removed and instrument turned on, set range to 1 mv. Measure the input impedance across #1 and #2 of input receptacle J2 using Resistance Bridge and DC Null Detector. If a reading of 10 megohms $\pm$ 1/2% is not obtained the following adjustment must be made: Remove the two #8 screws on each side of the cabinet near the front panel. Remove the two #6 screws on the rear of the cabinet. The front panel and amplifier assembly

can now be removed from the front of the cabinet. Remove the #4 screws securing the bottom plate to the amplifier and readjust the trimming capacitor C30 located at the base of the chopper socket XCH-1 with a non-metallic alignment tool.

Before proceeding with the checkout it is recommended that a check for + 190 VDC ± 10% between Amplifier Chassis and Pin 1 of V4 and + 150 VDC ± 3% between Amplifier Chassis and Standoff E1 (R9) be made.

Replace bottom plate and Amplifier Assembly in cabinet, and secure screws.

3.1. Connect input cable to input receptacle and short the black and red clips together. Set range to 100 μv and vary meter zero control (R86) from full CCW to CW. Meter should indicate approximately 50% of full scale on both sides of zero. Set range to 10 μv and reset to zero.

3.2 For accurate meter zeroing the input cable must be connected to the same source impedance, with no voltage present, that will exist for any particular range to be measured.

4.1. Set instrument to 10 μv range, set zero and apply 10 μv, either polarity, from DC voltage source to input cable. Adjust #1 control located on lower right side of cabinet for full scale deflection. Reverse polarity of test voltage and readjust #1 control if necessary to average the

was necessary, meter zero must be rechecked and calibration repeated.

4.2. Repeat 3.1 procedure for 30 μv range, adjust #2 control.

4.3. Repeat 3.1 procedure for 100 μv range, adjust #3 control.

4.4. Repeat 3.1 procedure for 300 μv range, adjust #4 control.

4.5. Repeat 3.1 procedure for 1000 μv range, adjust #5 control.

4.6. Check all ranges from 1 mv to 1000 V for full scale accuracy ± 3%. If the instrument is out of calibration on any range above 1 mv, repeat step 3.5 averaging out the error until all ranges from 1 mv to 1000 V are within the full scale accuracy of ± 3%. This completes the calibration of the voltmeter.

C. OPERATIONAL CHECKOUT-VOLTMETER AND AMPLIFIER OUTPUT

1. Set range to 10 μv and set zero, switch to 1 mv range and apply DC voltage for full scale deflection, record positive and negative indication.

2. Reduce line voltage to 105 VAC and repeat C.1.

3. Increase line voltage to 125 VAC and repeat C.1. The change in readings between C.1, C.2, and C.3 should not exceed 2% of C.1. Reset line voltage to 115 VAC.

4. Range set to 1 mv with no voltage input, connect the 1K Resistor in parallel with the VOM across the output terminals (plus terminal of the VOM to + output terminal). Vary Output Bias Adj. from full CCW to CW. The VOM should indicate less than zero with bias set CCW,

NOTE:

There are no calibration adjustments for the current ranges. Current is measured by the 95A in terms of the voltage drop across precision resistors switched internally across the input terminals. Hence the accuracy is dependent on both the precision of voltage indication and the precision of the inserted resistors.

Table I below shows the conditions for current measurements.

TABLE I
CONDITIONS FOR
CURRENT MEASUREMENTS

METER RANGE (F.S. CURRENT)	RESISTANCE SEEN BY CURRENT TO BE MEASURED (Inserted R)	DEVELOPED Across R- For F.S. Indication	METER VOLTAGE F.S. Voltage Divider Used to Produce 1 mv on Ranges down to & including 3 mv
1 A	1 Ω	1 V	1 mv
300 ma	1 Ω	300 mv	1 mv
100 ma	1 Ω	100 mv	1 mv
30 ma	1 Ω	30 mv	1 mv
10 ma	1 Ω	10 mv	1 mv
3 ma	1 Ω	3 mv	1 mv
1000 μa	1 Ω	1 mv	1 mv
300 μa	3.33 Ω	1 mv	1 mv
100 μa	10 Ω	1 mv	1 mv
30 μa	33.3 Ω	1 mv	1 mv
10 μa	100 Ω	1 mv	1 mv
3 μa	333 Ω	1 mv	1 mv
1000 mμa	1000 Ω	1 mv	1 mv
300 mμa	3.33K Ω	1 mv	1 mv
100 mμa	10 K Ω	1 mv	1 mv
30 mμa	33.3 K Ω	1 mv	1 mv
10 mμa	100 K Ω	1 mv	1 mv
3 mμa	333 K Ω	1 mv	1 mv
1000 μμa	1 MΩ	1 mv	1 mv
300 μμa	3.33 MΩ	1 mv	1 mv
100 μμa	10 MΩ	1 mv	1 mv
30 μμa	10 MΩ	300 μv	300 μv
10 μμa	10 MΩ	100 μv	100 μv
3 μμa	10 MΩ	30 μv	30 μv
1 μμa	10 MΩ	10 μv	10 μv

and more than +1 VDC with bias set CW. Set Output Bias Adj. for zero output.

5. Set output level control to maximum and apply + 1 mv to input. Output voltage should be more than + 1 V. Reverse polarity of input, output should be more than - 1 V.

6. Decrease output level to 1V output with output level control. Decrease input voltage by 20% steps to zero and increase in opposite polarity by 20% steps to 1 mv input. The instrument meter, and output level, non-linearity (or tracking error) should be less than 2% of full scale.

7. With no voltage input, set Output Bias Adj. for 1V output. Repeat c.6 output level will be 0 V with -1 mv input and +2 V with +1 mv input. Output non-linearity should be less than 2%.

With no voltage input, set Output Bias Adj. for 0 V. apply +1 mv input, replace VOM with the Ballantine. Output ripple should be less than .01 V. RMS.

D. OPERATIONAL CHECKOUT-AMMETER

Remove 1K Resistor and VOM from output posts. Remove DC voltage source from input cable. Set range to 1 μμa position and connect input cable to DC current source. It should be noted here that if the source of the current to be measured is in any way referenced to ground potential, the shorting link between ground and floating chassis terminals should be removed. Check all ranges from 1 μμa to 1000 ma. The full scale deflection should be within ± 4% of full scale.

To check operation on the most sensitive current ranges, a voltage is applied in series with a high resistance. For example, applying 20 μv in series with 10 megohms (± 1%) to the input of the instrument will produce a 10 μv

drop across the input, if the input resistance is the correct 10 megohms. The meter will indicate 10 μv F.S., since 1 μμa must flow under these conditions, it will correctly indicate 1 μμa F.S.

E. AMPLIFIER DRIFT AND NOISE CHECKOUT

1. Drift and noise measurements must be made after the instrument has been off at least one hour. If the shorting link has been removed for current measurements it must be replaced at this time. Replace the 1K load across output and set Output Bias Adj. for zero. On the 1 mv range apply +1 mv input and adjust output level control for +1 V output. Remove input voltage, 1K load, and replace input cable with a "U" shaped shorting bus across Pins 1 and 2 of input receptacle J2. Connect output - to #2 of Rustrak recorder, and output + in series with a 2.2K Ω resistor to #1 of recorder. (This sets the sensitivity of the recorder to equal the meter indication.) Switch to to 10 μv range and zero meter. Switch back to 1 mv range and adjust Output Bias Adj. for a half scale reading on recorder. Switch to 10 μv range and start recorder. The distance between the recorder and instrument under test should exceed 2 feet. The strong AC field from the recorder or any other source could cause indications which will affect the calibration & checkout of the instrument. After a 2 hour recording is completed, the recorded drift should be less than ± 2 μv after the first 1/2 hour. The noise (width of recorded output measured any time after the first 1/2 hour) should not be more than 1 μv peak to peak.
2. ZERO OFFSET CHECK with instrument set to 30 μv range and input open (cable removed), turn zero control to full CCW position. The meter should indicate more than -10 μv. Rotate zero control to full CW position, the meter should indicate more than +10 μv.

SECTION VI

TABLE OF REPLACEABLE PARTS

Reference	Description				BEC Part No.
C1	Capacitor, Mylar	0.022	µf	200V	230,101
C2A	"	Elec.	20	µf	475V	283,109
C2B	"	Elec.	50	µf	50V	--
C2C	"	Elec.	20	µf	25V	--
C3	"	Elec.	50	µf	6V	283,112
C4	"	Mylar	0.005	µf	200V	230,121
C5	"	Mylar	0.005	µf	200V	230,121
C6	"	Elec.	5	µf	6V	283,108
C7	"	Mylar	0.005	µf	200V	230,121
C8	"	Mylar	0.005	µf	200V	230,121
C9	"	Mylar	0.1	µf	200V	230,116
C10	"	Mylar	0.1	µf	200V	230,116
C11	"	Mylar	0.1	µf	200V	230,116
C12	"	Met. P	1.0	µf	200V	230,104
C13	"	Elec.	50	µf	6V	283,112
C15	"	Met. P	0.05	µf	200V	230,117
C16	"	Mylar	0.022	µf	200V	230,101
C17	"	Met. P	0.05	µf	200V	230,117
C25	"	Mylar	0.022	µf	200V	230,101
C26	"	Mylar	0.022	µf	200V	230,101
C27	"	Mylar	0.1	µf	200V	230,116
C28	"	Mylar	0.1	µf	200V	230,116
C29	"	Sil.Mica	300	µµf	500V	201,128
C30	"	Var.Mica	37-250	µµf	500V	275,118
C31	"	Mylar	0.33	µf	200V	234,032
C32A	"	Elec.	20	µf	475V	283,113
C32B	"	Elec.	20	µf	475V	--
C32C	"	Elec.	20	µf	475V	--

Reference		Description			BEC Part No.
C33	Capacitor, Elec.	50	µf	50V	283,143
C34A	" Elec.	1000	µf	15V	283,114
C34B	" Elec.	1000	µf	15V	--
C35,36,37	" Ceramic	.05	µf	100V	224,117
CH-1	Chopper	BBM-Special			540,108
CR-1	Rectifier, Sel.	Sarkes-Tarzian #304B			532,001
D2	Diode	IN1775			530,026
D3	" Zener	14V 3/4W 10%			530,019
F1	Fuse	AGC 0.5 AMP			545,502
I1	Lamp	GE #323		3V	545,106
I2	Lamp	GE #323		3V	545,106
I3	Lamp	TS 47		6V	545,101
I4	Lamp	TS 47		6V	545,101
L1	Choke	Stancor #C1707 7Hy			440,001
M1	Meter	Special 100-0-100 µa			554,120
Q1	Transistor	2N34 PNP			528,001
R1	Resistor	6.8 Meg.	1/2W	5%	301,179
R2	"	1 Meg.	1/2W	1% *	306,598
R3	"	1 Meg.	1/2W	5%	301,159
R4	"	1 K	1/2W	5%	301,087
R5	"	47K	1/2W	5%	301,127
R6	"	2.2 Meg.	1/2W	5%	301,167

Reference		Description	BEC Part No.
R7	Resistor	1 Meg. 1/2W 5%	301,159
R8	"	10 K 1/2W 5%	301,111
R9	"	47 K 1/2W 5%	301,127
R10	"	2.2 Meg 1/2W 5%	301,167
R11	"	470 K 1/2W 5%	301,151
R12	"	1 Meg. 1/2W 5%	301,159
R13	"	2.2 Meg 1/2W 5%	301,167
R14	"	100 K 1/2W 5%	301,135
R15	"	2.2 K 1/2W 5%	301,095
R16	"	1 Meg 1/2W 5%	301,159
R17	"	470 Ω 1/2W 5%	301,079
R18	"	18 K 1/2W 5%	301,117
R23	"	10K 1/2W 5%	301,111
R24	"	18 K 1/2W 5%	301,117
R26	" Variable	1 Meg. 2W 20% Level	311,133
R27	"	1 Meg. 1/2W 5%	301,159
R28	"	2.7K 1/2W 5%	301,097
R29	"	3.3K 1/2W 5%	301,099
R30	"	1 Meg. 1/2W 5%	301,159
R31	"	820K 1/2W 5%	301,157
R32	" Variable	25 K 2W 20% Bias Adj	311,115
R33	"	6.8K 1/2W 5%	301,107
R34	"	15K 1/2W 5%	301,115
R35	"	56K 1/2W 5%	301,129
R36	"	100K 1/2W 5%	301,135
R37	"	18Ω 1/2W 5%	301,045
R38	"	330K 1/2W 5%	301,147
R39	"	220K 1/2W 5%	301,143
R40	"	8.92 Meg. 2W. 5% *	323,501
R41	"	220K 1/2W 5%	301,143
R42	"	100K 1/2W 5%	301,135
R19	" Dep.Car.	10 meg. 1/2W 1%	306,635
R20	" " "	10 meg. 1/2W 1%	306,635

Reference		Description	BEC Part No.
R43	Resistor	150K 1/2W 5%	301,139
R44	"	2.2K 1/2W 5%	301,095
R45	"	1 Meg. 1/2W 1% *	306,698
R46	"	1.5K 1/2W 5%	301,091
R47	"	Variable 1K 2W 20% (1) Adj.	311,100
R48	"	Variable 2K 2W 20% (2) Adj.	311,114
R49	"	1.2K 1/2W 5%	301,189
R50	"	Variable 2K 2W 20% (3) Adj.	311,114
R51	"	Variable 15K 2W 20% (4) Adj.	311,109
R52	"	22K 1/2W 5%	301,119
R53	"	Variable 25K 2W 20% (5) Adj.	311,115
R54	"	33K 1/2W 5%	301,123
R55	"	68K 1/2W 5%	301,131
R56	"	233 Ω 1/2W .5% *	321,009
R57	"	66.7 Ω 1/2W .5% *	321,012
R58	"	23.3 1/2W .5% *	321,007
R59	"	6.67 Ω 1/2W .5% *	321,006
R60	"	2.33 Ω 1/2W .5% *	321,005
R61	"	1 Ω 3W .5% *	309,011
R62	"	244K 1/2W .5% *	321,508
R63	"	66.7K 1/2W .5% *	321,270
R64	"	23.3K 1/2W .5% *	321,269
R65	"	6.67K 1/2W .5% *	321,257
R66	"	2.33K 1/2W .5% *	321,268
R67	"	1K 1/2W .5% *	321,267
R68	"	3.9 Meg 1/2W .5% *	321,511
R69	"	1.1 Meg. 1/2W .5% *	321,510
R70	"	6.67K 1/2W .5% *	321,257
R71	"	2.33K 1/2W .5% *	321,268
R72	"	667Ω 1/2W .5% *	321,010

Reference		Description		BEC Part No.
R73	Resistor	233 Ω 1/2W .5% *		321,009
R74	"	66.7 Ω 1/2W .5% *		321,012
R75	"	23.3 Ω 1/2W .5% *		321,007
R76	"	10 Ω 1/2W .5% *		321,004
R77	"	6.67 Meg. 1W .5% *		322,501
R78	"	9 Meg 1W .5% *		322,502
R79	"	9.66 Meg. 1W .5% *		322,503
R80	"	9.9 Meg. 1W .5% *		322,500
R81	"	5 Meg. 1/2W .5% *		321,512
R82	"	1.1 Meg. 1/2W.5% *		321,510
R83	"	345K 1/2W .5% *		321,509
R84	"	66.7K 1/2W .5% *		321,270
R85	"	23.3K 1/2W .5% *		321,269
R86	" Variable	50K 2W 20%	Zero	311,108
R87	"	120K 1/2W 5%		301,137
R88	"	15K 1/2W 5%		301,115
R89	"	1K 1/2W 5%		301,087
R90	"	1K 1/2W 5%		301,087
R91	"	18K 2W 5%		303,631
R92	"	1 Meg. 1W 20%		302,128
R93	"	4.7K 1W 5%		302,117
R94	"	7.5K 10W 10%	WW	312,100
R95	"	3.9K 2W 5%		304,101
R97	"	2.2K 1/2W 5%		301,095
R98	"	250K 1/10W 20%		311,122
R99	"	10 Ω 1/2W 5%		301,039
R100	"	10 Ω 1/2W 5%		301,039
R101	"	12M 1/2W 5%		301,185
R102	" Met. Film	3.9K 1/2W 5%		315,002
R103	" Met. Film	3.9K 1/2W 5%		315,002

Reference		Description	BEC Part No.
S1	Switch	4 pole 7 pos. Special	466,136
S2	"	8 pole 7 pos. Special	466,137
S3	"	SPST Carling #110-63	465,105
T1	Transformer	Power, Special	446,007
V1	Electron Tube	12AX7 Special	525,001
V2	"	6AU6	526,6AU6
V3	"	12AT7	526,12AT7
V4	"	12AT7 Special	525,002
V5	"	6X4	526,6X4
V6	"	OA2	526,OA2

WARRANTY

Boonton ELECTRONICS Corporation guarantees to the original purchaser that each instrument it manufactures be free from defects in material and workmanship for a period of one year after date of initial shipment. Our liability is limited to repairing or replacing any defective part with the exception of vacuum tubes, panel lamps, fuses, and batteries. The warranty lapses if, upon our examination, we judge that the instrument has been abused in any way.

PROCEDURE TO FOLLOW WHEN INSTRUMENT IS DEFECTIVE

1. Call our plant or our representative nearest you. A simple solution may result from discussion of the problem with our trained personnel.
2. If the fault is not readily eliminated, prepare the instrument for return to us. Pack carefully in a sturdy container using several inches of shock absorbing material on all six sides of the instrument. Include all probes, cables or accessory units. On all paper work pertaining to the returned instrument, note the model and serial number and state briefly the details of the fault. Ship to us transportation charges prepaid.
3. If the instrument is within the warranty, we will repair and return to you transportation charges prepaid. If the instrument is beyond the one year warranty period, we will repair and return it unless approval on a cost estimate is requested. If the instrument is within the one year warranty period, but our examination reveals abuse, we will await approval of our cost estimate before proceeding with repairs.

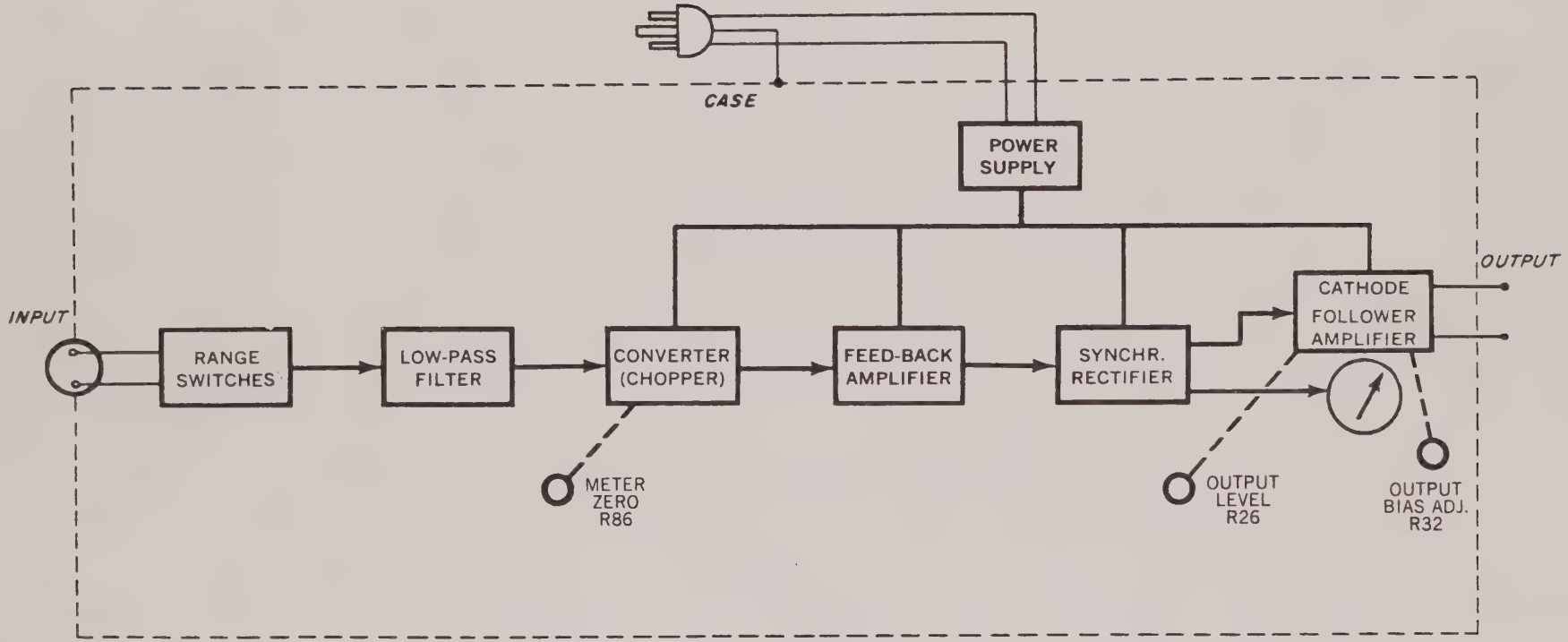
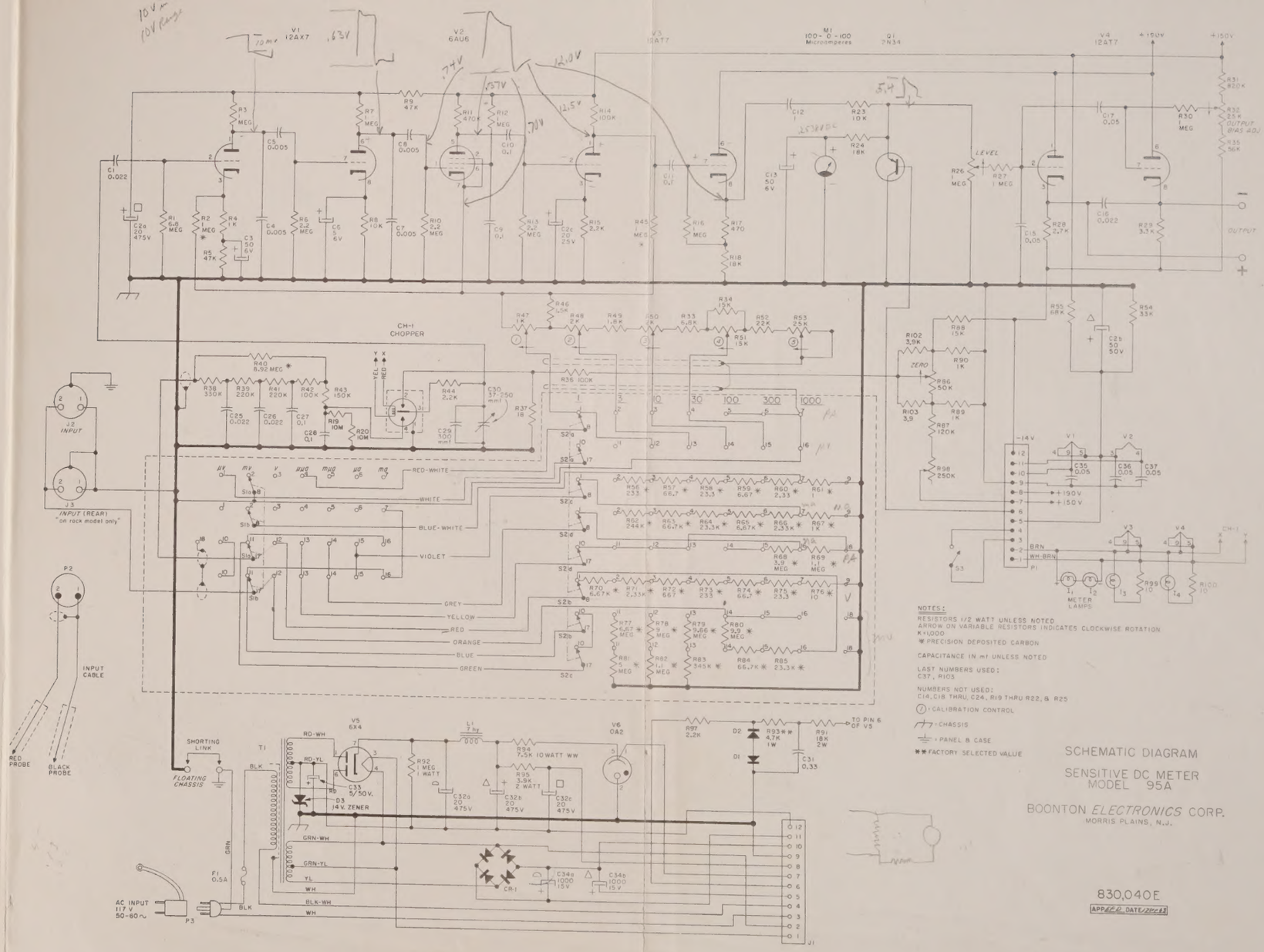


Fig. 1

Block Diagram --

Model 95A Sensitive DC Meter



NOTES:
RESISTORS 1/2 WATT UNLESS NOTED
ARROW ON VARIABLE RESISTORS INDICATES CLOCKWISE ROTATION
K=1000
* PRECISION DEPOSITED CARBON
CAPACITANCE IN mf UNLESS NOTED
LAST NUMBERS USED: C37, R103
NUMBERS NOT USED: C14, C18 THRU C24, R19 THRU R22, & R25
Ⓒ = CALIBRATION CONTROL
⏚ = CHASSIS
⏚ = PANEL & CASE
** FACTORY SELECTED VALUE

SCHEMATIC DIAGRAM
SENSITIVE DC METER
MODEL 95A

BOONTON *ELECTRONICS* CORP.
MORRIS PLAINS, N.J.

830,040E
APPR'D DATE 12-14-53

EARLE & JONES INC.
NEW YORK
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